A multi-isotope and modelling approach to understanding groundwater sustainability in a biodiversity hotspot impacted by anthropogenic activity

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The Verlorenvlei freshwater estuarine lake system on the west coast of South Africa is a RAMSAR listed biodiversity hotspot but is strongly impacted by agricultural development and in recent years, severe drought conditions linked to the 2014-2016 El Niño cycle. In this study, O, H, $^{3}H/^{3}He$, ^{14}C, $^{87}Sr/^{86}Sr$ along with cations and anions were used to (1) identify the different aquifer systems, and (2) track the relative contributions of different tributaries into the lake system. Simultaneously, rainfall/runoff modelling was used to model the relative contributions of the four main feeding tributaries. Whilst all the isotopic tracers where useful for differentiating the three dominant aquifer systems, $^{87}Sr/^{86}Sr$ was particularly valuable as a "forensic tool" to identify a missing groundwater input to the Verloren River, the feeder river into the lake. Previous work suggested that the Krom Antonies tributary of the Verloren River was the dominant source of freshwater into the lake system. However, $^{87}Sr/^{86}Sr$ ratios of the Verloren River were significantly lower than those of the Krom Antonies. The resultant "hunt" for the additional groundwater input identified the Bergvallei tributary is a large contributor to freshwater flows, and this was subsequently supported by rainfall/runoff modelling. The most surprising aspect was the ability of the $^{87}Sr/^{86}Sr$ ratios to differentiate the tributaries, despite the aquifer geology being almost identical. Resilience of the Verlorenvlei lake system to climate change has been considered in terms of managing water balances in the Krom Antonies sub-catchment but should also consider the Bergvallei sub-catchment, for which almost no data exists.